LATE HOLOCENE CLIMATE VARIABILITY and VEGETATION RESPONSE in the E SIERRA NEVADA and W GREAT BASIN

The last 100-3500 years

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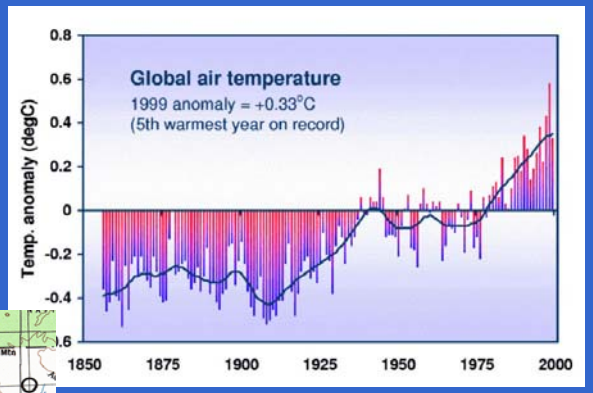
- **Decadal Response of High Elevation Pines to 20th Century Climate**



a) **Meadow Invasion**

20th Century Responses: Meadow Invasion

Methods:

- 9 meadows, 6 east- & 3 west-Sierra crest, 2645-3050m
- metamorphic-, granite-, volcanic-based soils
- livestock grazing: 95 yrs non-use to active; varied fire
- line transects, 3m circular plots at 15m intervals
- 10 trees cored (>1m ht) + 10 trees internodes (<1m)
- N = 693 trees

b) Snowfield Invasion

Pines have invaded formerly persistent snowfields during the 20th century

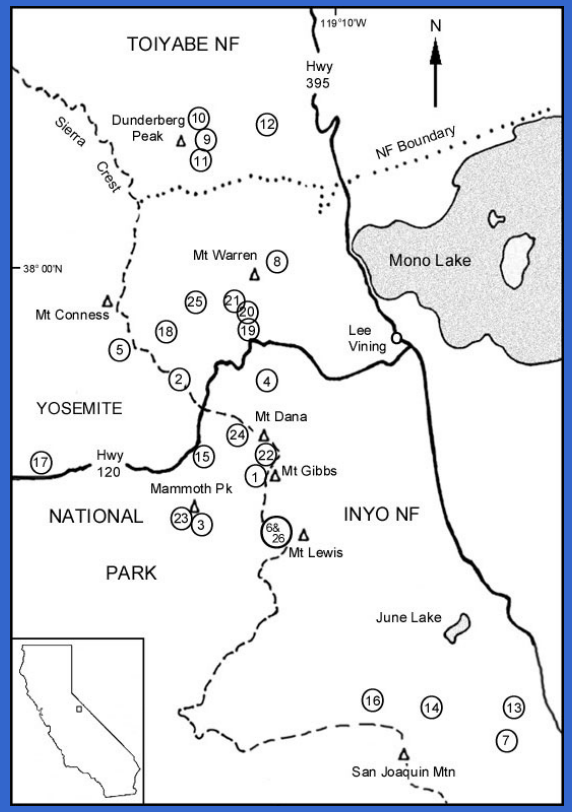
20th Century Responses: Snowfield Invasion

Methods:

- 6 sites, volcanic and metamorphic soils, 2730-3100m
- northern aspects, slopes 16-21°
- line transects, 3m circular plots at 15m intervals
- 10 trees cored (>1m ht) + 10 trees internodes (<1m)
- N = 643 trees

c) Vertical Branch
d) Annual Stem Growth

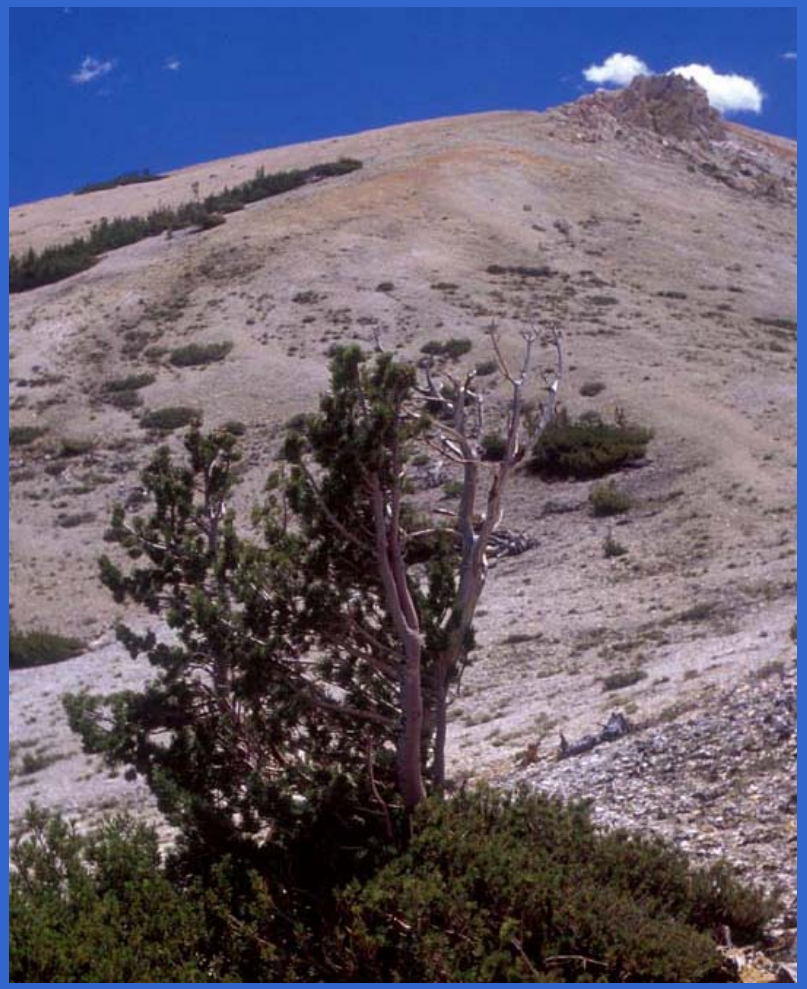
Krummholz whitebark pine at treeline



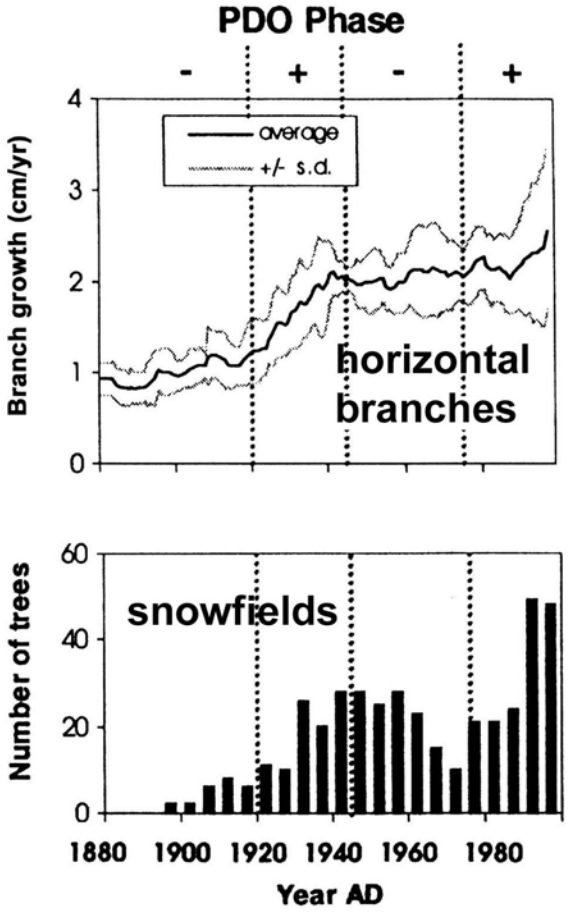
20th Century Responses: Krummholz Pine Branch Growth

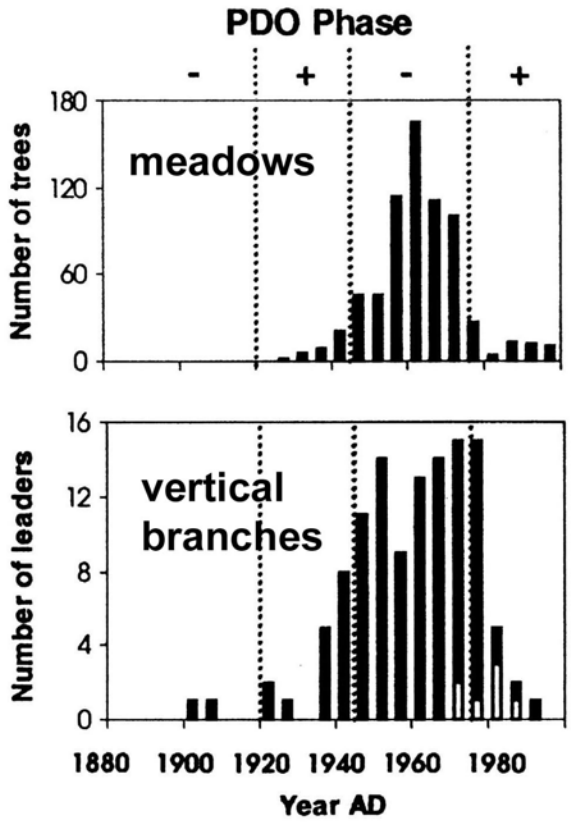
Methods:

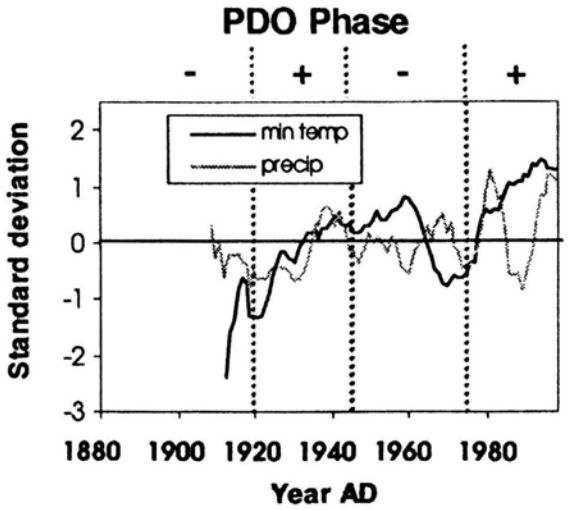
- 6 sites, volcanic, 5 west/1 east side of Sierra crest
- granitic, metamorphic soils, 3430-3565m
- southern aspects, slopes 17-27°
- dated vertical stems at base of crown
- dated internode cross-sections
- N = 150 vertical stems
- N = 849 horizontal branches



20th Century Responses: Summary 4 Studies



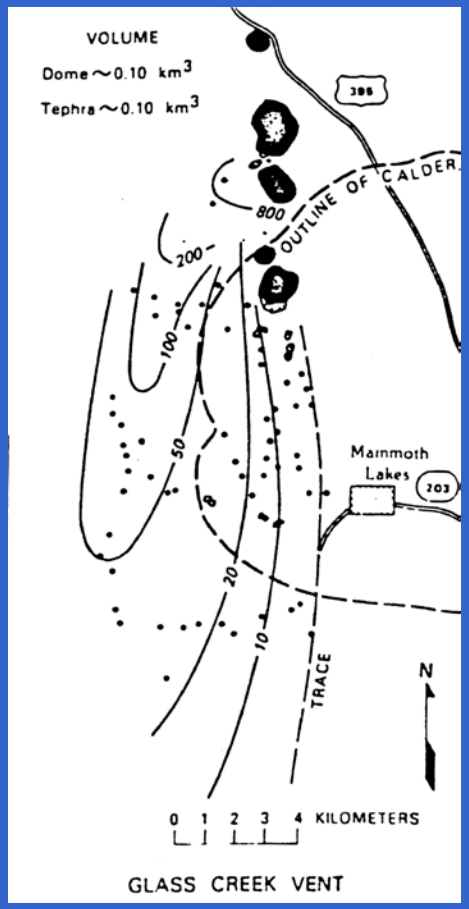


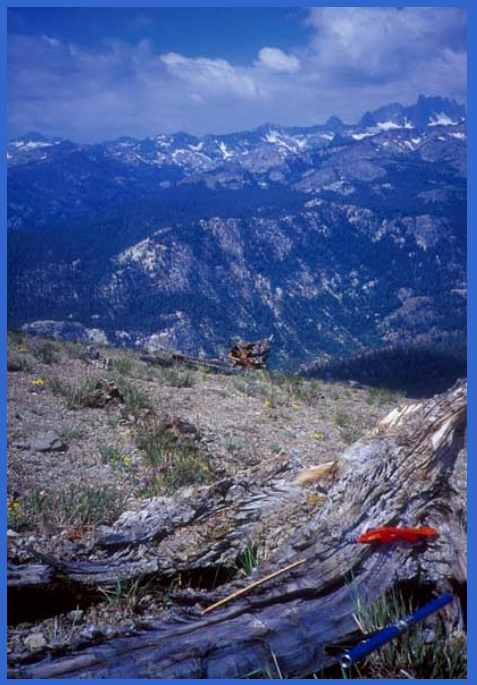


2. Century-Scale Response of Vegetation to Climate Change during the last 1000 Years

Volcanic eruptions, climate change, and forest dynamics at Whitewing Mtn and Glass Creek Watershed, Inyo National Forest

Glass Creek Vent Eruptions (Inyo Craters)
500-700 ybp; 1200 ybp; undated older eruptions





Deadwood Species

San Joaquin: 17 *Pinus albicaulis*

North Point: 5 *P. flexilis*

WhiteWing: 20 *P. albicaulis*

20 *P. monticola*

3 *P. lambertiana*

8 P. contorta

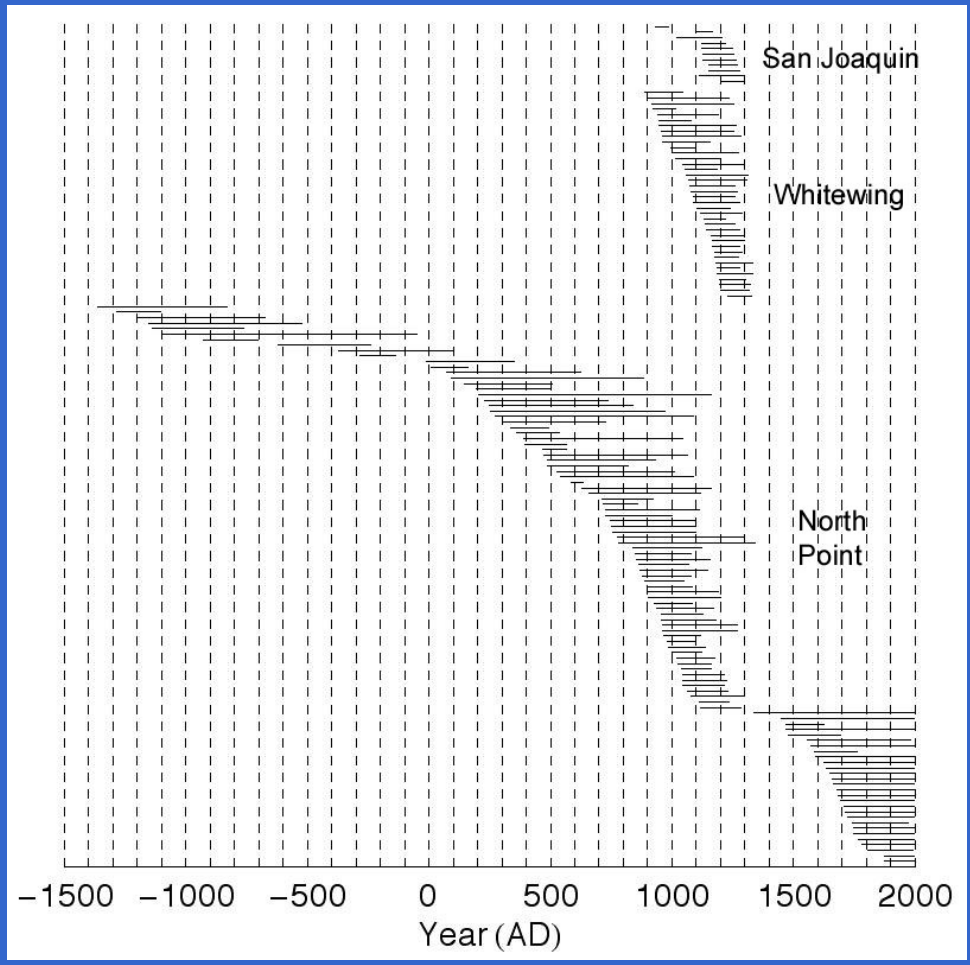
2 P. jeffreyi

1 Tsuga mertensiana

Stump bases attached & rooted:

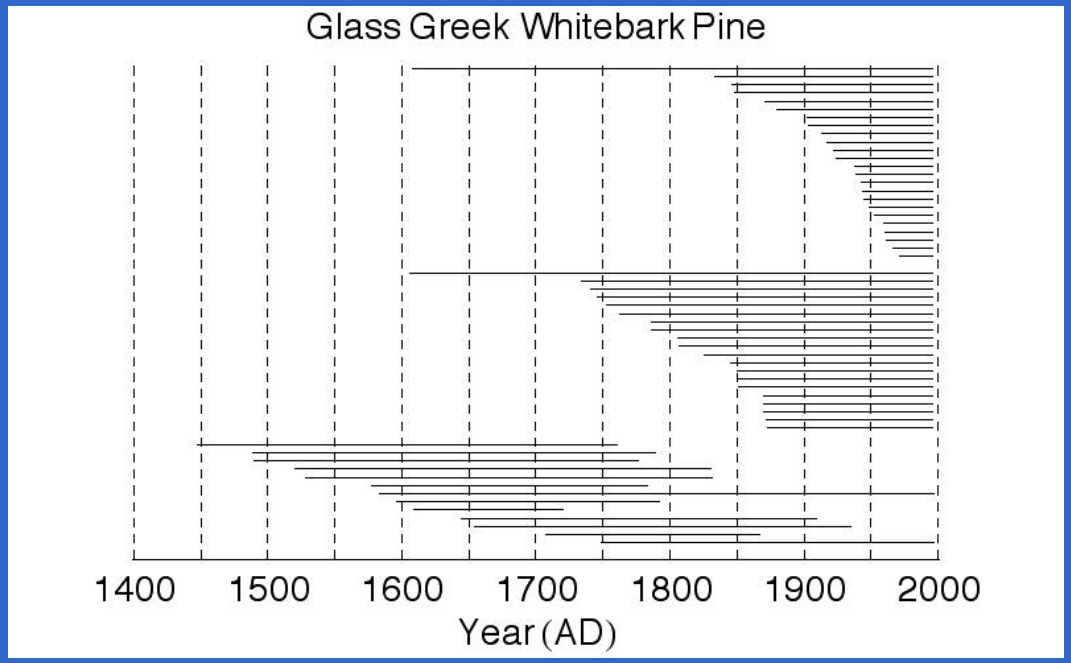
only *P. albicaulis, P. flexilis*

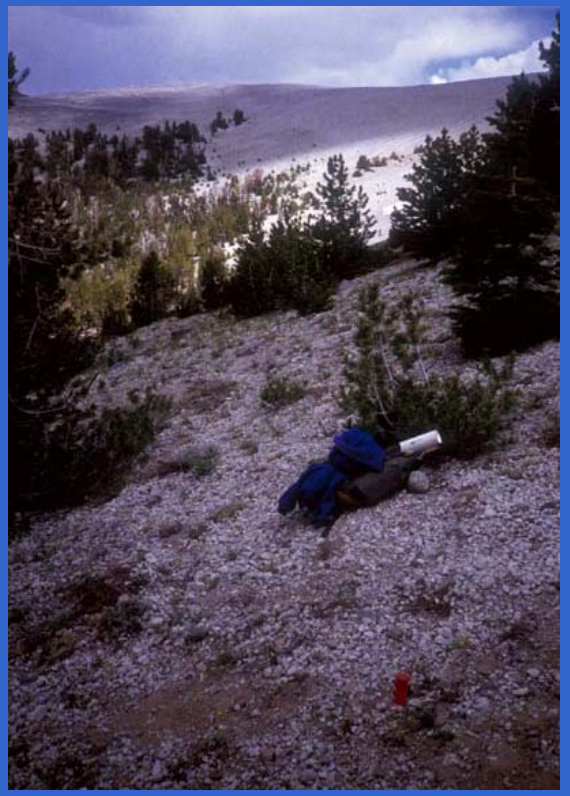
Dated Deadwood and Live Tree Series



1. Best estimate, Glass Creek Vent eruption AD 1350, ~650 ybp
2. Whitewing series AD 900 - 1327
   = Medieval Climate Anomaly (Stine Droughts 1-2)
3. No regeneration post-eruption Whitewing or San Joaquin
4. Eruption gap in regeneration North Point

Upper forest border changes in *P. albicaulis* post eruption





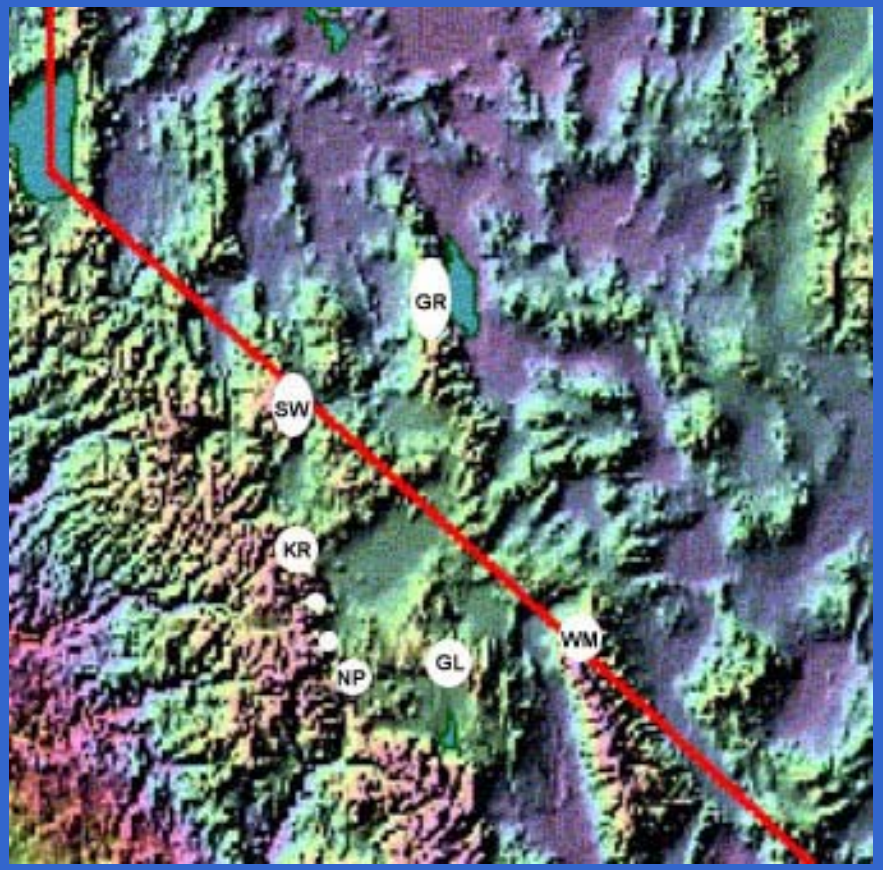
3. Millennial-Scale Response of Pines to Climate Change of the last 3500 Years

Reconstructing climate and ecological variability

Limber Pine (*Pinus flexilis*)

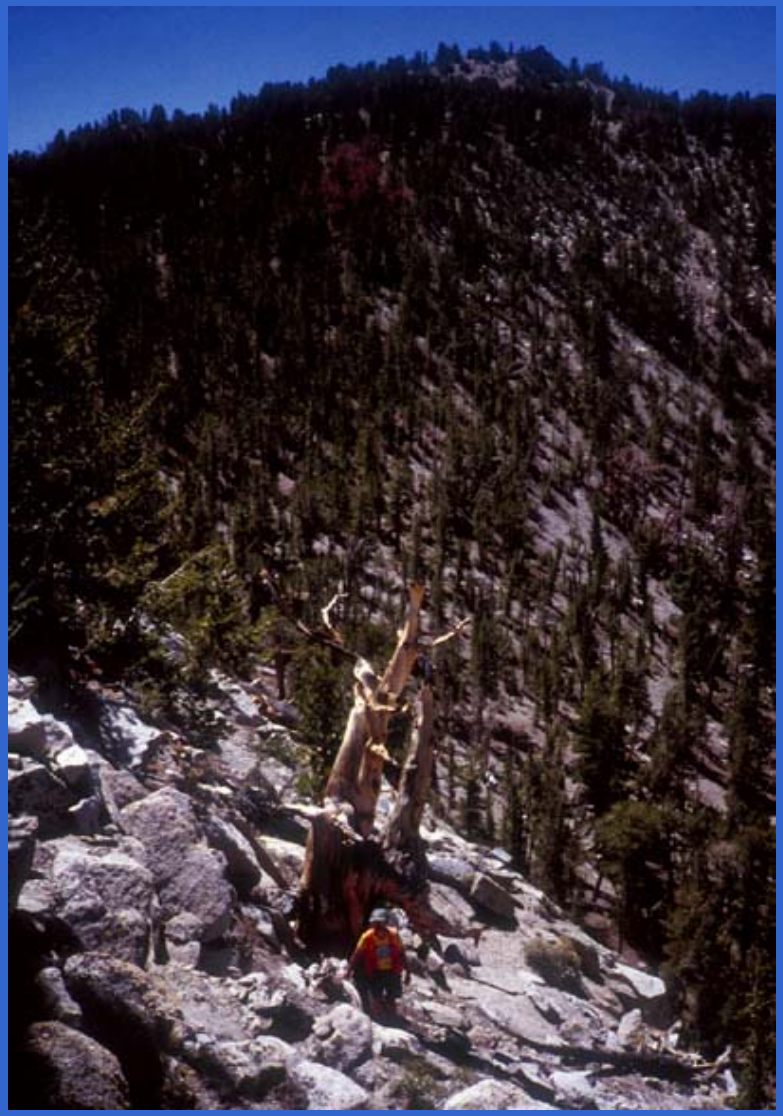
E Sierra Nevada
W Great Basin:

6 Regions
18 Sites
>100 trees/Site



Limber Pine…

…*at North Point* (Glass Cr Watershed, N of Mammoth Lks)

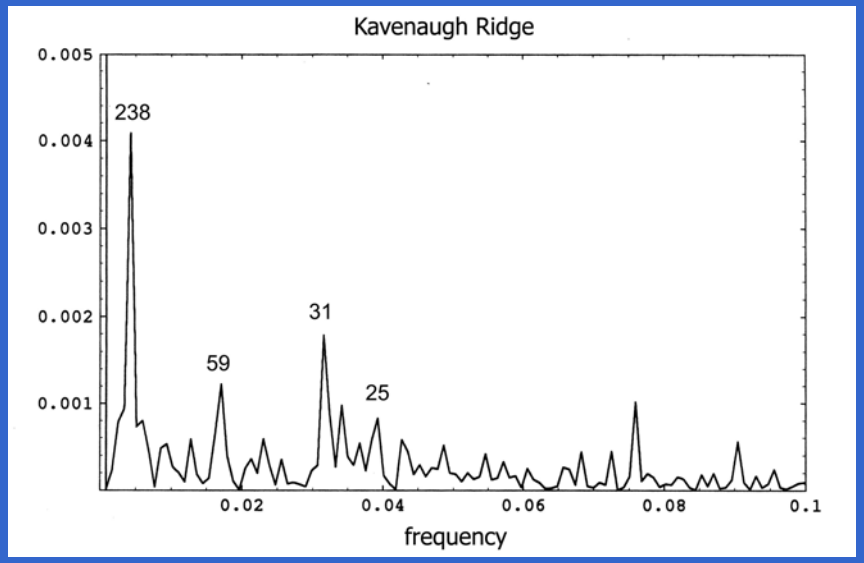


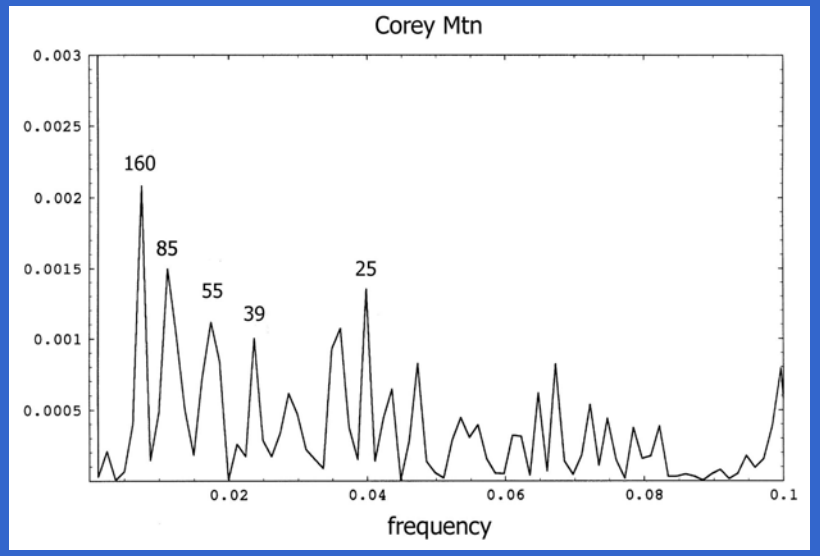
Limber Pine…

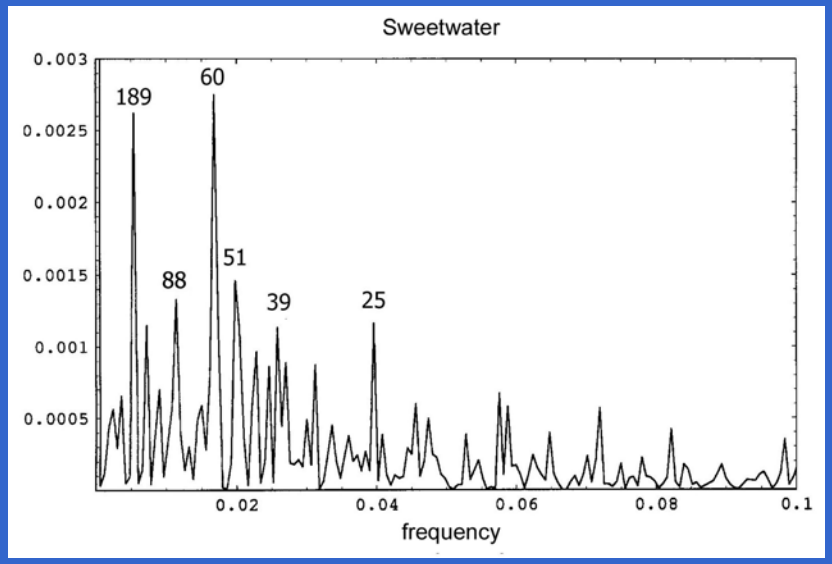
…*at Sweetwater Canyon* (E side of range)

Spectral Analysis

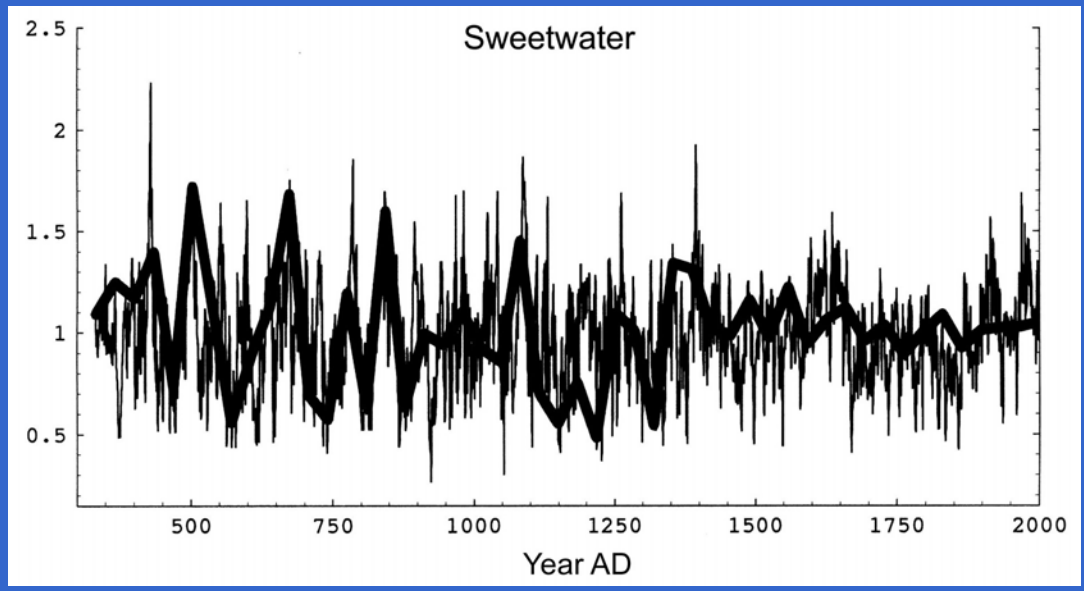
Sierra Nevada (Kavenaugh), Sweetwater, Wassuck (Cory)

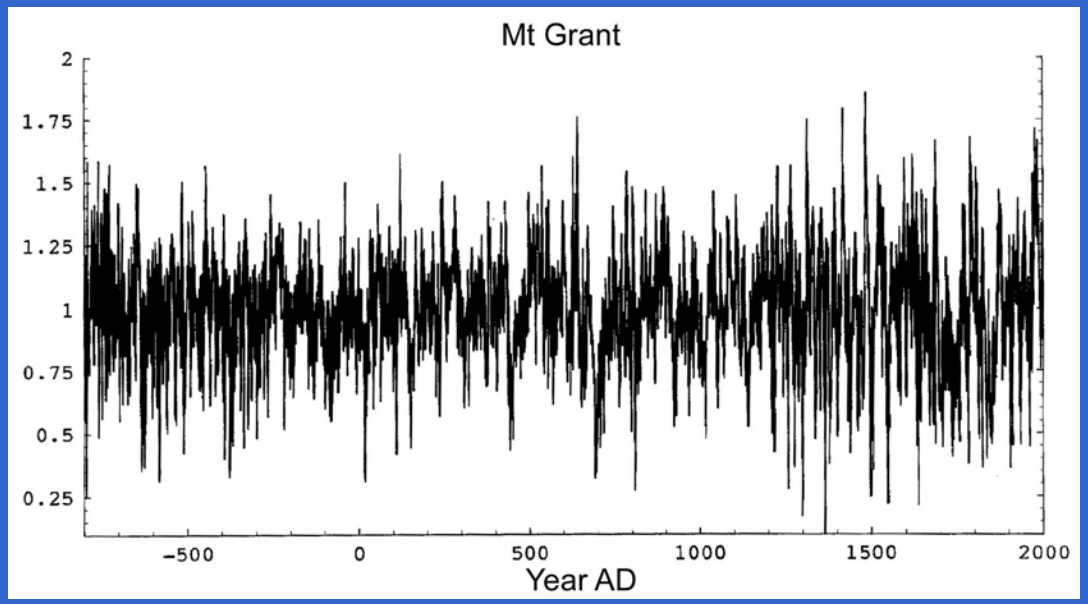






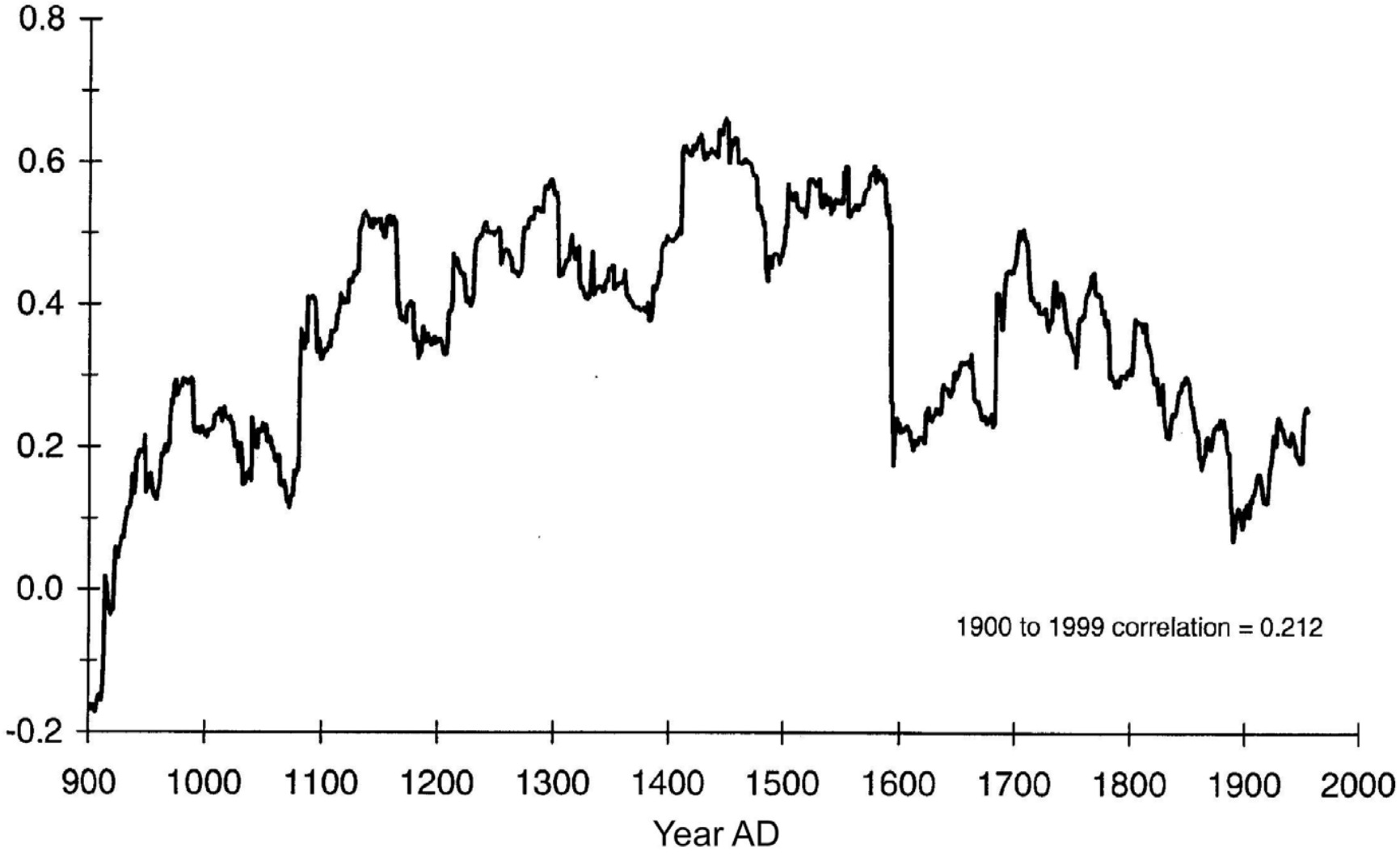
Century Scale Patterns

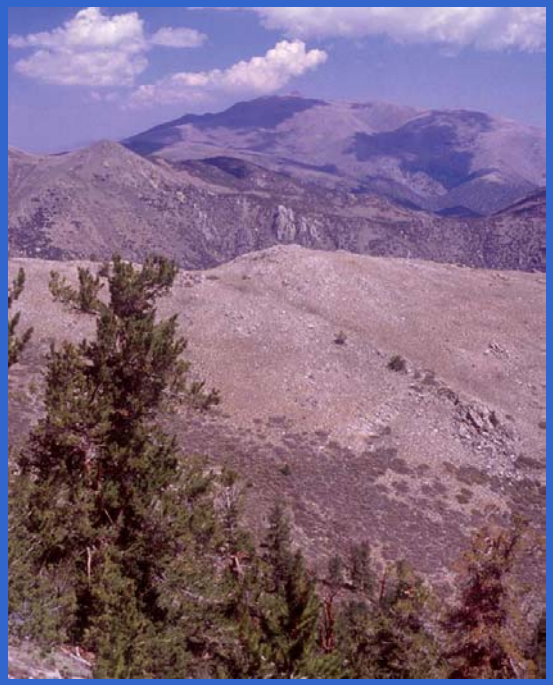




Grant vs KR 91-year High-Frequency Correlations

Note: Low-frequency features were removed prior to analysis using a 9yr spline and log transformation





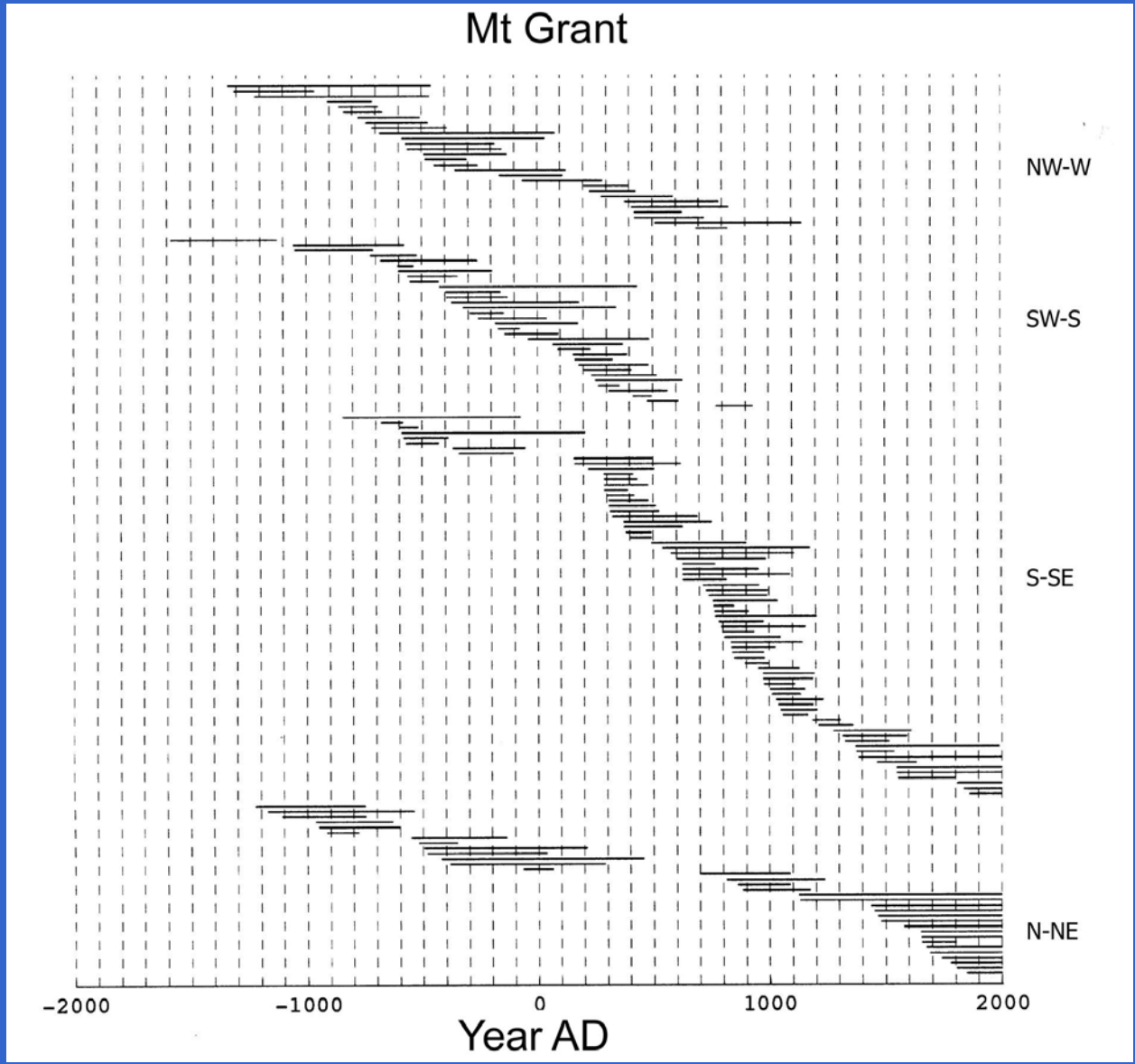
Limber Pine Demography

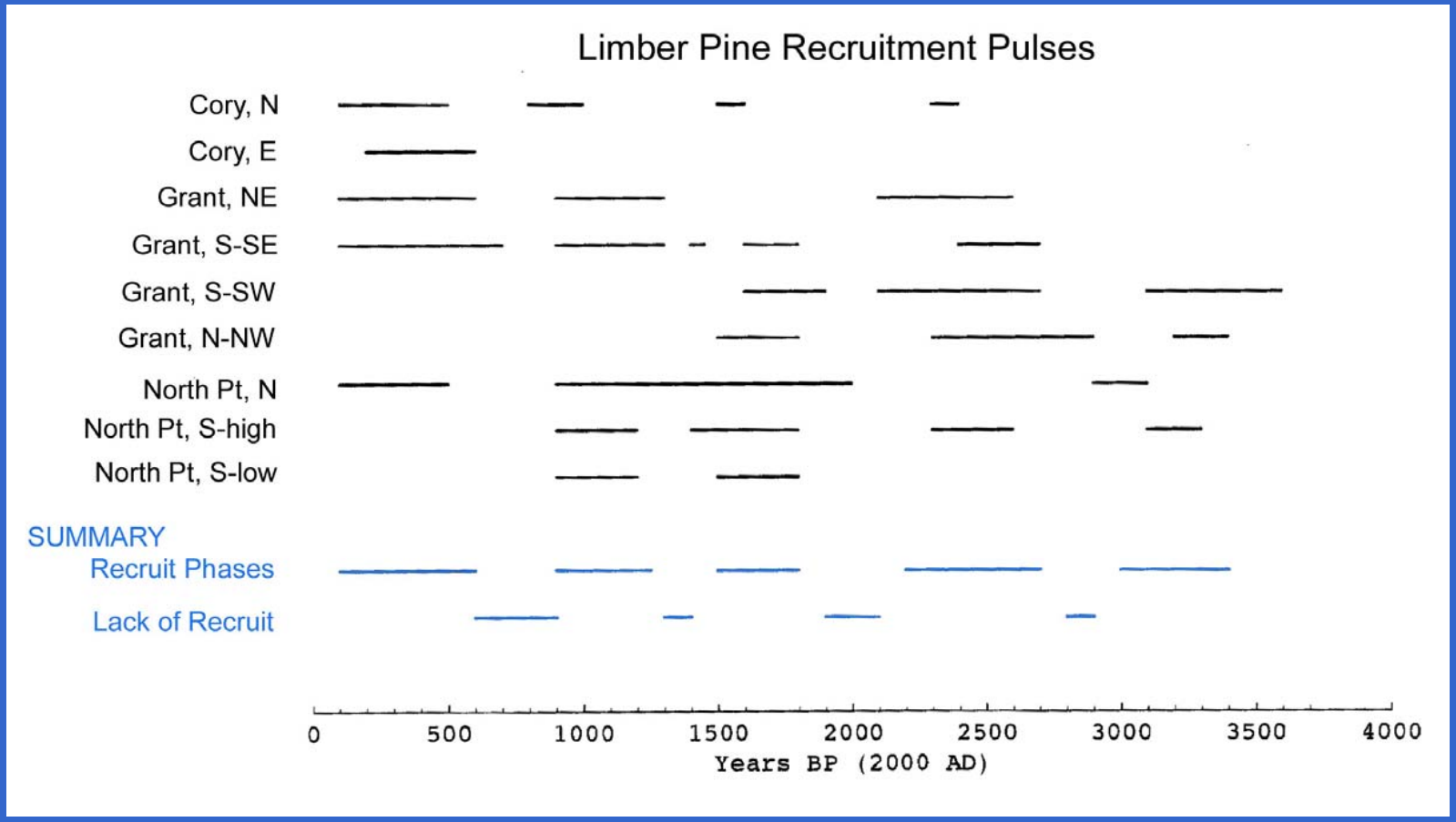
Wassuk Range, NV

Remnant Stands
on NE Aspects, to 10,200’

Deadwood Only
on N, NW, W, SW, S, SE Aspects

Mt. Grant Limber Pine Deadwood and Live Tree Series





600-800: Stine, Walker, Pyramid, Mono, Owens, Tree Rings, Springs, Pinyon

1300-1400: Walker, Pyramid, Tree Rings, Pinyon

1900-2100: Pyramid, Springs, Pinyon

2100-2700: Walker dessicated

2800-2900: Pyramid

Conclusion Last 3500 Years (Limber Pine)

- Regional climate variability corroborated at high elevations
- Inter-regional and intra-regional variability
- Complex climate relations
- Significant watershed scale population fluctuations and extirpations